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VOL. LX SEPTEMBER 12, 1924 No. 1550

CONTENTS

The Rôle of Research in Medicine: PROFESSOR C. M. JACKSON 227

Recent Achievements in Paleobotany: DR. G. R. WIELAND 233

White Indians of Darien: PROFESSOR H. L. FAIRCHILD 235

Scientific Events:

The World Power Conference; The Health Committee of the League of Nations; The National Physical Laboratory; Expedition of the Bishop Museum 237

Scientific Notes and News 240

University and Educational Notes 242

Discussion and Correspondence:

American Uses of Globes before 1800: PROFESSOR L. C. KARPINSKI. *On the Excretory Apparatus in Paramecium:* R. A. YOUNG. *The Resistance of the Typhoid Bacillus to Freezing:* STANLEY THOMAS. *Analyzed Sound:* H. A. ALLARD, CHARLES K. WEAD 243

Scientific Books:

Scott on Extinct Plants and Problems of Evolution: PROFESSOR EDWARD W. BERRY 245

Special Articles:

Regulation of the Movement of Cilia: PROFESSOR CASWELL GRAVE. *Physiological Specialization in Fomes Pinicola Fr:* DR. HENRY SMITH. *Series Regularities in the Spark Spectrum of Nitrogen:* DR. C. C. KIESS 246

The American Association for the Advancement of Science:

The Section of Geology 250

Science News x

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THE RÔLE OF RESEARCH IN MEDICINE[1]

IN the old-fashioned, proprietary type of medical school which flourished in this country during the nineteenth century scientific research was neglected. Even where nominally associated with a university, the medical school was usually dominated by a rather narrow professional purpose, in which investigation was largely ignored. Though incidental research might be tolerated as a harmless diversion, it was more often discouraged as a mere waste of time and of no practical value. Contributions to the medical literature were usually superficial in character. As a rule, the highest ambition of the professor was to publish a text-book, which might establish or extend his fame, even though it represented no advancement of the subject through original research.

The revolution in medical education at the close of the past century brought many radical changes. The proprietary type of organization has been abandoned. We now recognize that the medical school must necessarily be an integral part of a strong university. In the reorganization of medical schools, the university ideal has become dominant. This ideal involves the search for the unknown, as well as the dissemination of the known. The modern medical schools have accepted this responsibility, and have made systematic efforts to provide for research as well as for teaching. They have recognized their duty to advance the science of medicine, in addition to the training of practitioners. Vast expenditures of money have been made to provide the personnel and facilities necessary for this purpose.

But revolutions tend to be followed by counter-revolutions. Especially in this restless, post-war period of discontentment, when all our social institutions are being challenged, it is not surprising that our medical schools are again subjected to criticism. Their efficiency has been questioned and their methods closely scrutinized. Among other things, doubts have been expressed concerning their present policies in the promotion of research. A reconsideration of the whole question of medical research and its relation to medical education therefore appears desirable.

Scientific research in general may be considered in two different aspects. Its first purpose is the increase of knowledge. With all our boasted progress, how little as yet we really know of the physical universe. Recent developments have shattered our former ideas

[1] An address at the commencement exercises of the Medical Department, University of Georgia, Augusta, June 2, 1924.

about even the structure of matter, the fundamental theories we had vainly supposed to be firmly established. And if our knowledge of the relatively simple phenomena of physics is still so inadequate, how much greater is our ignorance of the vastly more complex living organisms with which biology and medicine have to deal! Yet even the little we know forms our only basis for progress. Though still groping in darkness we have occasional glimpses of a promising future. The only hope for improvement is through continued investigation, which therefore demands our earnest attention and our continued support. The need is beyond question.

The scientific method is generally recognized as the road leading toward the desired goal. Yet there is apparently a prevalent misconception concerning the manner in which knowledge actually grows. This misunderstanding hampers the progress of all science, including medicine. To make adequate provision for continued progress, it is highly important to understand the actual mode of the growth of knowledge, which is really a process of evolution.

We may perhaps profitably compare the general process of the growth of knowledge to the development of America. First came Columbus and the other discoverers and explorers, who led the way and revealed the main features of the country and its various regions. Next were the colonizers, who established settlements at numerous convenient or strategic points. From these sources, the pioneer settlers slowly spread in various directions. The subsequent actual occupation of the country and the development of its resources were accomplished through the enterprise and energy of thousands of leaders in agriculture, industry, commerce and associated activities. But the efforts of all these numerous leaders would have been quite fruitless without the assistance and support of the millions of individual workers. Each of these played his part in making the latent resources actually available for us all. Even to this day every citizen participates to some extent in the making of America, a continuous, never-ending process. Thus leaders and followers alike are indispensable for social progress.

A somewhat similar process occurs in the extension of the bounds of knowledge. A popular but erroneous idea is that advancement is accomplished solely by the inspiration of a few great geniuses. These are, of course, essential and invaluable, but their discoveries are never entirely independent. They always represent the culmination of a series of steps or stages, including the thoughts and efforts of numerous previous workers in the same or related fields. In a very real sense, "there is nothing new under the sun." So interrelated and interwoven are the infinite parts of our common body of knowledge that they seem to form a vastly complicated mechanism, like a living, growing organism. The new develops from the old. From the very nature of things, an entirely new discovery would be quite incomprehensible to our minds. It could not be assimilated, and is therefore a practical impossibility. Every apparently new idea has its roots reaching far back into the past, and also its branches extending into the future.

By extension into the future, I mean that no discovery is completely established on first appearance. By sad experience, we have learned that caution is necessary in accepting even the most plausible new theory. Before its merit as truth is finally determined, it must be repeatedly tested and tried in its various relations. Its range and its limitations must be determined. It must run the gauntlet of skepticism by its opponents on the one hand, and of unwarranted enthusiasm and credulity by its advocates on the other. Through the inevitable test of experience, every new idea or discovery, whether great or small, thus gradually passes from the realm of uncertainty, and as confirmed approaches (but never quite reaches) the goal of absolute certainty. This applies to abstract truths or general principles and likewise to their applications, to both discoveries and inventions. The evolution of human knowledge is thus a process in which we all participate, consciously or unconsciously. In admiring the achievements of genius, we should not forget the important aid of the many plodders of lesser talent.

Nowhere is this more true than in the field of medicine. No discovery in the basic medical sciences, no advancement in the art of healing is to be credited to any single individual. Even the greatest heroes of medicine, those most richly endowed with the precious gift of creative imagination, are indebted to their predecessors for instruction and inspiration, to their contemporaries for criticism, and to their successors for the final adaptation and evaluation of their most original products. The pages of the history of medicine are crowded with examples with which you are all familiar.

The important discovery of the hormone secretin by the English physiologists, Bayliss and Starling, may serve as an instance. In referring to this work, Starling recently said:

> It was of no practical use to any one, but a source of much gratification to ourselves, since it seemed to open up a new chapter in our knowledge of the body. But there were at that time half a dozen workers skating along the edge of the discovery, and it is difficult to comprehend why, for example, Wertheimer and Lepage did not take the one further step which would have made them and not us the discoverers of secretin. . . . Every discovery, however important and apparently epoch-making, is but the natural and inevitable outcome of a

vast mass of work, involving many failures, by a host of different observers, so that if it is not made by Brown this year it will fall into the lap of Jones, or of Jones and Robinson simultaneously, next year or the year after.

Similarly, credit for the recent discovery of insulin belongs to no one man, nor even to any small group of men. Banting and Macleod, to whom the Nobel prize in medicine was awarded, very generously and properly shared it with their colleagues, Best and Collip. While these Toronto investigators fully deserve the greatest praise for their achievement, it is nevertheless well known that many others had previously worked on this problem, clearing up various preliminary stages and even coming very close to the final solution. It is unnecessary to rehearse the interesting story, which involves the unconscious cooperation of hundreds of workers, even to go back no farther than the discovery of the pancreatic islets by Langerhans in 1869. The subsequent elucidation of the nature and function of these islets required the patient labor of a long series of morphologists, physiologists, pathologists, biochemists and clinicians. According to tradition, one important step (the experimental production of diabetes by extirpation of the pancreas) was due partly to a German laboratory *Diener,* who happened to observe a sweet taste in some crystals formed by the evaporation of urine from the test animals. Accident thus plays a part in scientific research, though, as Pasteur remarked, "chance favors the prepared mind."

But even with the discovery of insulin, the subject was by no means exhausted. Literally thousands of workers, both laboratory scientists and clinicians, are now actively engaged in a further study of insulin, its chemical structure, physiological significance, standardization for clinical use, methods and limitations in various stages and complications of diabetes and in numerous other related problems. The utilization of insulin in country practice, in contrast with its use where laboratory and hospital facilities are available, raises a series of questions which can be answered only by the test of experience. It is believed that further research upon insulin will shed light on other obscurities of metabolism, with results which eventually may prove even more important than the conquest of diabetes mellitus. At any rate, this problem has enlisted the efforts of a multitude of workers interested in the various phases of what is really a huge, loosely cooperative investigation to perfect and extend our knowledge of insulin.

The recent advances in the field of nutrition, as related to the deficiency diseases, likewise represent the results of a large number of workers in various countries. The history of the discovery and application of the diphtheria antitoxin (on which work still continues), and the problems of scarlet fever and of goiter are other examples from the many which could easily be cited.

I would like to emphasize the fact that even the ordinary practitioner in the smallest village, far from hospital, laboratory or library, can, if he will, make *some* contribution to medical progress. It is unnecessary to remind this audience of Crawford W. Long, the rural doctor who first used ether anesthesia in a surgical operation. Another Georgia physician, Robert Battey, was the first to remove the ovaries for the relief of intolerable dysmenorrhea. I commend to you, members of the graduating class, these examples of your distinguished fellow-citizens as demonstrating what may be accomplished, even under very unfavorable conditions. While you may not be so fortunate as to make great discoveries, it is your privilege and duty to do what you can in the promotion of medical research. Each one of you should strive to repay at least slight interest on your great indebtedness for the common social heritage of our present medical science. If you will cultivate the scientific spirit, if you will make your observations accurately and record them carefully, if you will later study critically your own data (or make them available for the use of other workers), and if you will honestly test your conclusions, you can not fail to promote in some degree the advancement of medicine.

There are, indeed, certain important phases of medicine for the study of which the opportunities are in some respects most favorable in small communities. For example, various hereditary aspects of disease can be studied most readily in rural districts, where the population undergoes relatively little migration. Here likewise the effects of racial intermixture upon predisposition and immunity can be most easily followed. Or, as a more practical problem, it would be interesting and instructive to compare the complications met in a large series of obstetrical cases in country practice with those found in the city or under hospital conditions. Every physician of an inquiring mind, wherever he may be located, can readily find all about him numerous medical problems of importance, which he can help to solve. Whether his ability and opportunity be great or small, it is his duty to make the most of them. Aristotle long ago noted that: "The search for Truth is in one way hard and in another easy; for it is evident that no one can either master it fully or miss it wholly. But each adds a little to our knowledge of Nature, and from all the facts assembled there arises grandeur."

The recognition that mediocrity must share with genius in the advancement of science is a matter of practical importance. Therein lies the answer to those who urge that progress would be facilitated by concentrating the support for scientific research into grants or prizes limited to the few investigators of

the first rank. These gifted individuals should, of course, be rewarded and honored. The most ample facilities should be placed at their disposal. But let us not make the serious mistake of failing to recognize also the value of the contributions from the lesser lights. Their work is likewise indispensable, and each deserves encouragement and support in proportion to his merits. Our efforts to promote progress through scientific research should therefore be directed not merely to the training and support of a few talented investigators, but to securing the maximum result by aiding wisely the activities of all. While many agencies may cooperate in the prosecution of research, we naturally look to the schools as the most potent factor in the promotion of science.

This brings up the second aspect of the research question. While the resultant increase of knowledge would fully justify all our efforts to promote scientific research, there is another reason equally good, though often overlooked or unappreciated. It is the educational principle that all instruction is most effective when imbued with the research spirit, inculcating the scientific method.

Let us first examine this question in its relation to general education, with which medical education is inseparably connected. We may assume that the primary purpose of education is to afford training which will aid in solving the problems of life. Broadly speaking, the methods of education, past and present, may be classified under two headings: the dogmatic and the scientific. Until quite recent times, education has been almost exclusively by the dogmatic method. The underlying principle of this method is to provide a system of rules for the guidance of conduct, or, in other words, a set of ready-made solutions for the problems of life. The teacher "lays down the law"; the student accepts it passively. Learning is chiefly through memorizing from lecture or text-book. This, the method of authority, has been a favorite throughout the ages, and is still predominant.

Doubtless many of you can recall personal experience with this system, especially in the elementary schools. In arithmetic, where there was perhaps the best opportunity for independent thinking, you noted that many students, through laziness or inability, relied entirely upon their classmates to solve the set problems. The more able and industrious faithfully worked out these problems, following the rules and "examples" as given in the text-book, but with little or no comprehension. Occasionally an ingenious pupil might actually dare to propose an original solution, to the astonishment of the class and (often) to the perplexity of the teacher. In the other branches of study, the methods were similar. Memorization was everywhere at a premium, and originality discouraged.

While conditions have undoubtedly improved, there is ample evidence that the cultivation of independent thinking in our schools and colleges, though recognized in theory, is still too rare in practice. The dogmatic method stubbornly persists, in spite of the efforts of numerous educational reformers, who, from time to time, have tried to introduce the scientific method as the basic principle of pedagogy. The pioneer in this attempt was Comenius, who nearly three centuries ago urged that:

> Men must, as far as possible, be taught to become wise by studying the heavens, the earth, oaks and beeches, but not by studying books; that is to say, they must learn to know and investigate the things themselves, and not the observations that other men have made about the things. We shall thus tread in the footsteps of the wise men of old, if each one of us obtain his knowledge from the originals, from the things themselves, and from no other source.

Rousseau likewise insisted that our first teachers are our hands and eyes. "To substitute books for them does not teach us to reason, it teaches us to use the reason of others rather than our own; it teaches us to believe much and know little." Rousseau expressed what is now termed the heuristic method as follows: "Let him know nothing because you have told him, but because he has learnt it for himself. Let him not be taught science, let him discover it." The same plea has been echoed in vain by subsequent reformers, down to the present day. Even in the teaching of the sciences, the dogmatic method, rather than the scientific or heuristic, has generally prevailed.

This heuristic plan of teaching seems to be in especial accordance with the nature of childhood, where curiosity is so prominent. Every normal child is a living question mark and an eager investigator. Soon, however, this native curiosity seems largely to disappear. Is it merely outgrown, along with other primitive characteristics of the childish mind? Is it stifled by our artificial mode of education? Or does it still persist, though diverted into other less obvious channels? The answer to these questions is important for our present theme, because the research spirit depends to a large degree upon the persistence of curiosity as a mental trait. While society encourages scientific progress for utilitarian purposes, the strongest motive for research in the individual is the desire to know. An unquenchable thirst for the truth is the chief stimulus of scientific investigation.

While this primitive spirit of inquiry persists in every one to some extent, in most individuals it apparently weakens. Conservatism notably increases with age. Human nature prefers to follow the lines of least resistance, and drops readily into the well-worn channels of custom. Innovations are disturb-

ing and are therefore subconsciously resented. This perhaps may help to explain why authority and book-worship remain so strongly intrenched, and why the scientific attitude makes slow headway in our schools.

Another drawback is the greater difficulty and expense of teaching by the scientific method. It requires more able teachers and more extensive equipment. As a result only feeble and sporadic attempts have yet been made to train students in the systematic application of this method to the problems of life. It is true that the pedagogic doctrine of formal discipline has been abandoned, and it is realized that no specific form of training gives ability to cope with other problems quite different in character. Nevertheless, in school work mental and physical habits are formed, and these do carry over and affect behavior in new and different situations. This possibility gives science unique significance in education, and justifies great hopes for the future.

The obvious defects in our present system of general education naturally limit the possibilities of later medical instruction. Medical students begin their work handicapped by inadequate earlier training. They have already passed the youthful age of greatest mental plasticity, when desirable habits and attitudes are most easily established. Medical teachers often complain that the incoming students memorize readily but are notoriously deficient in powers of independent observation and reasoning. Especially in the earlier years of the medical course, it is necessary to devote much time and energy to training in scientific method, if this is to be made the basis of medical education. Great emphasis is therefore laid upon scientific research, even during undergraduate work, because it is assumed that the same principles and methods are required for efficiency later in the practice of medicine.

But is this a valid assumption? Some writers have lately challenged this principle, asserting that while scientific research is desirable for the advancement of knowledge, it bears no relation whatever to efficiency in practice. Thus a recent critic (in "Our Medicine Men, by One of Them") states that "there is no such thing as a science of medicine and that the study of disease is a matter distinctly apart from the art of healing"; that clinical practice "is entirely antithetical to the spirit of science"; and that in medical education "what is necessary is a sharp delineation between the practical sheep and the scientific goats. This should take place at the very beginning of the medical course."

An editorial in a recent number of *Surgery, Gynecology and Obstetrics,* criticizing undergraduate medical teaching, likewise asserts that, "If perchance we should occasionally turn out a scientist or an embryo discoverer, so much the better, but it is a fatal mistake to try to make all our students research workers in the hope that one or two of each class may ultimately turn out to be a real scientist."

A prominent physician, in a recent article on medical education, similarly maintains that:

> There is no place in the actual practice of medicine for sustained medical research. It is condemned by law, and, according to all moral standards, is a reprehensible practice. No man employs a physician to advance science at his expense and risk. No man would knowingly tolerate it. If a student is taught to do research work on his patients in the university hospital and is complimented on something great or small in connection with it, he might become convinced that that was a proper or permissible course—convinced, in a word, that the patient is only a sort of advanced laboratory animal. Could he then reasonably be expected to disgorge his mind of all these impressions and become an honest servant of his patrons on graduation? Would he not feel justified in trying out his new ideas on them?

The obvious reply is that all depends on the definition of research. That every case presents a new scientific problem has often been pointed out and is generally admitted. Every patient is not only willing but anxious to be the subject of scientific research, if he understands that to mean the most careful attempt to discover the exact nature of his affliction, and to find the most appropriate and efficient remedy. The scientific spirit is entirely consistent with the highest humanitarian motives, which make the welfare of the patient the foremost consideration.

It would indeed be hard to find a better example of scientific methods than the ordinary procedure in medical practice. The diagnosis represents the first step in the analysis of the problem. For the discovery of the existing facts, the case history is taken. This is followed by a systematic and careful examination to reveal the present state of the patient, the observer using both the unaided senses and the various instruments of precision. In seeking the cause of the disorder, provisional hypotheses must be verified or corrected by comparison with the observed data, and by further tests for purposes of differential diagnosis. The prognosis really represents a scientific prediction, the validity of which is tested by the outcome. The choice of treatment is a deduction from the diagnosis, under all the ascertainable conditions affecting the individual case. The results of treatment further confirm or disprove the previous line of reasoning. Rational principles likewise determine the method by which the recurrence of the disease is most likely to be prevented. Thus medicine exemplifies the typical scientific methods of observation, hypothesis, deduction and experimental verification.

As Barker puts it:

The study of a single patient by modern methods includes the making of a very large number of experiments, that is, of test procedures adopted on the chance of their yielding to observation under especially controlled conditions definite information that is not obtainable by simple non-experimental observation. There is no other science in which the technic of accumulating facts is as extensive as in clinical medicine, for its methods of examination are based on and include the technical methods of all the preliminary natural sciences and of all the intermediate, simpler preclinical sciences.

In contrast with this concept of medicine as a science, we have what may be styled the empirical method, which disdains science as impractical, and attempts to deal directly with the phenomena on the basis of experience. The empiric generally treats merely the symptoms, or the symptom-groups (syndromes), which are designated as the various diseases. He scorns the scientific concept as theoretical and visionary. Yet often he is unconsciously himself a slave to the most absurd theories, which lead him far astray. Empiricism sometimes achieves brilliant success, but more frequently results in failure. As Minot once remarked, the difference between the so-called practical doctor and the truly scientific is that the patients of the former are more likely to die. The scientific practitioner looks beyond the symptoms and persistently seeks to remove the real cause of the disorder, by more difficult but more rational methods. He knows and frankly admits his own limitations, which is the beginning of scientific wisdom. Success in practice demands scientific judgment and practical skill, both of which are dependent upon the character of the previous training, though perfected by further experience.

We should, therefore, protest against the custom of designating the fundamental branches of medicine as "scientific," in contrast with the "clinical" subjects, which by implication are thereby considered unscientific. The methods used are, or should be, essentially similar in all parts of the field of medicine. The primary aim of the practitioner is to interpret and control the clinical phenomena. The purpose of medical education is to give the training which makes this possible, through a working knowledge of the human organism under both normal and abnormal conditions. Mastery of the basic data and their utilization at the bedside alike require the persistent application of the same scientific methods by which all knowledge is discovered. While medical instruction can not possibly foresee all the specific problems which will arise in practice, it can and should provide the methods of procedure by which the future practitioner will be able to meet and solve these problems in the most effective manner. The more thoroughly medical practice becomes imbued with the spirit of scientific research, the more successful will it be.

The scientific method should, therefore, be made the guiding principle throughout the medical curriculum. In all medical instruction, it should be kept constantly in mind. Every teacher should be an active investigator. Moreover, I firmly believe that every medical student, at some time during his course, should have the opportunity to undertake on his own account a modest bit of original research in the more formal sense. Although the resultant contribution to the common stock of knowledge in most cases would be slight, the experience would be invaluable in giving him a better grasp of the scientific method, its uses and its limitations. The limited elective system in the medical curriculum, now growing in favor, gives this needed opportunity. If adopted in all first-class medical schools, this system would provide, or at least make possible, a good substitute for the medical thesis, an ancient requirement still maintained in the best medical schools abroad. This encouragement of productive scholarship helps to emphasize the scientific character of medicine.

The application of scientific research to the problems of medicine will doubtless result in the improvement of medical practice, not only along the conventional lines, but also in opening up new modes of treatment. For example, the study of psychology in its relation to medicine presents, in my opinion, one of the most promising and fruitful fields of the future. I refer not merely to psychiatry, but to the psychic aspects of medicine in general. Psychotherapy has been sadly neglected by the medical profession, though largely utilized in empirical fashion by various cults and quack systems. Medical science should be open-minded and devoid of prejudice, ever ready to recognize the truth, whatever its source. Great possibilities are in store for the future, perhaps in directions entirely unexpected.

In our efforts to promote medical progress we must be not only tolerant but patient. We must not expect results too quickly. In medicine, as in other fields, we should realize that "Science moves, but slowly, slowly, creeping on from point to point." The achievements of the past, however, encourage us to look hopefully to the future. We are on the right path and moving in the right direction. And with the more general recognition and support of the scientific method in medical education and practice, we may confidently expect that improvement will become increasingly rapid and certain.

In conclusion, let me repeat that in medicine as elsewhere the rôle of scientific research is twofold. In the first place, it presents the indispensable means for the continued growth of our common body of knowledge, a process in which plodding talent must cooperate with creative genius. In the second place, it provides also the methods by which this knowledge can be most efficiently applied in solving the daily

problems of life. We must, therefore, recognize the fundamental importance of the research spirit, for education in general as well as for medical training and practice.

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RECENT ACHIEVEMENTS IN PALEOBOTANY

UNTIL within the last few years a sort of forbidding lonesomeness has seemed to attend the student of fossil plants. Paleobotany is in fact the last of the paleobiologic trio to reach accuracy and finality in the methods of research employed. Above and beyond the discovery of new materials, the great need is men. There are far too few workers in definitely recognized paleobotanic positions which make active contribution possible—in all the world a few over twenty. In Germany there is Gothan, Kräusel and R. Potonié; in Sweden, Halle; in France, Carpentier and Paul Bertrand; in Austria, Kubart; in Holland, Jongmans; in Great Britain, Kidston, Lang, Scott, Seward, Benson, Weiss, Stopes, Oliver; in India, Sahni; in the western world, Knowlton, Berry, Noé, White, Jeffrey, Wieland, Goldring, Torrey, Chaney.

Where the workers are so few, contributions uniformly fail of needed criticism, and such comment as does rise to the surface may not have a sufficiently constructive effect. Only in subjects where elaborators are active and their fields somewhat overlap, does criticism become an organic, functioning thing—a force such as can carry the study of ancient plant life to the goal. There is pith in the remark of Dr. Marie Stopes that "paleobotany requires a serene civilization."

Turning to actual discoveries the initial dates may serve. Taking the past thirty-five years, that is, the close of the last century and the opening of the present, the outstanding discoveries and elaborations in the larger fields are: Seed cone of Bennettites Morierei, Lignier, 1894; finding of new localities of American cycads, Macbride, Ward, '93–94; volumes on the status of the Mesozoic floras with initial description of cycadeoids by Ward, '99–'05; cycadeoid collection and discovery of fructification and foliage, Wieland, 1898–99; early Williamsonians, Nathorst, 1902; great development of "coal ball" study by the British group of paleobotanists leading to the publication of great text-books on fossil plants and especially to the determination of the seed ferns by Oliver and Scott, 1903; taxonomy and distribution of American Carboniferous floras by White with codiscovery of seed ferns; the microspore-bearing disk Codonotheca, Sellards, 1903; chemical methods and demonstration of Williamsonians by Nathorst, 1907; sustained investigations of American dicotyledonous floras by Knowlton and Berry; brilliant study of the Kreischerville lignites by new methods, Hollick and Jeffrey, 1909; many Mexican Williamsonians with the latest of the typical Cordaite floras, Wieland, 1916; Rhynia of the lower Old Red of Scotland, the most primitive of vascular plants, Kidston and Lang, 1917; extension of the Hollick and Jeffrey methods to wider studies of lignitic gymnosperms of Cretaceous time, Torrey, 1923; collection and initiation of microscopic study of an immense series of American "coal balls," Noé, 1923; the Gilboa forest plants of the Upper Devonian of New York, Goldring, 1924.

While it is unlikely that any of these events, discoveries and accomplishments will seem to diminish in importance as the years pass by, others not mentioned may be found significant. Other names stand out, such as Zeiller, Grand-Eury, Bertrand, Gothan, Pelourdé. Although when the present century draws to a close some reviewer will surely throw into broader and fuller light as an outstanding event of these earlier years the discovery of the Pennsylvanian "coal balls." There doubtless are calcified parts of coals of extensive occurrence in other horizons than the Carboniferous. But it already appears that if any pre-Cretaceous forests may ever be fully and thoroughly reconstituted from a cosmopolitan record they must be those of the coal swamps. It is improbable that vegetal life of other periods can ever be so extendedly visualized from precise structure. The coal itself, both bituminous and anthracite, has been recently found from polished surfaces etched by flame to have the structures of lignites and of the "coal balls." Only in the latter (petrified parts of coal seams) has nature done the staining and imbedding for the investigator, who merely requires application of the simpler but well-carried-out arts of the lapidary and thin sectioner of rocks.

Just 69 years have passed since Joseph Dalton Hooker and Edward William Binney turned their attention to the seeds of the coal balls, and it appears incredible that Americans should have let all these years pass away without noting or reporting a single coal ball or cutting a single thin section from such, if a few sections of English material cut at Yale be excepted. However, the American coal balls are all at once here from Illinois, Indiana, Kentucky, Texas; and they are the key to a record of imposing extent and importance. What limits may be set to the data these great accessions may be made to yield no one now living may say. As we stand at the threshold of this new era in the study of ancient plants, the question of questions is, What were the ancestors of the Jurassic and lower Cretaceous dicotyls? Are the

recent glimpses suggesting intense parallelism and great antiquity of forest types illusory? It seems not.

Professor Noé and one of his students announce the presence of angiospermous and in fact monocotyledonous structure in the materials already sectioned, although their view meets adverse criticism. Correctness or error here must depend on later more elaborate study and should not be too strongly affixed to any initial descriptions. Noé and Hoskins dismissed identity of the stems (or petioles) revealed by their sections with Myeloxylon the petiole of Medullosa, to which especially so great an authority as Seward pointedly objects. How far can objection be sustained? Or, if there is a mere presence of Medullosan structures, are such throughout more gymnospermous than angiospermous? *Possibly they are not.* If each type of tracheid, vessel, stem or flower or finally fossil plant, suggesting the presence of a link in angiosperm descent, is to be summarily cast out because the evidence is incomplete or contrary to old interpretations or on the ground that only a so-called pteridosperm is concerned, the riddle of angiosperm origin can never be solved. Yet no one would maintain that the early angiosperms, letting the word for convenience include the line of descent as far back as flowers may go, those for instance of Permian time, were not numerous.

The Medullosa of Cotta is widely known, and the later study, down to interesting comparisons with Heterangium and Lyginopteris, indicates early gymnospermous features—mainly cycadeous. No more than when Weber about 1880 found that Myeloxylon was the petiole of Medullosa could any one until very recently have suspected the presence of a Medullosan angiospermous relationship or antecedency. But the cycadeoids throw all ancient cycad-like structures under suspicion of relationship to the earlier angiospermous phyla. They were complex of habit, cosmopolitan in distribution and their floral plan was that of the flower of Linnaeus. Moreover, it is not the later cycadeoids but exactly the Triassic Wielandiella that first suggests angiosperm affinity; while the Medullosans as a detached group of highly variant structure may well include members near if not within the line of angiosperm descent. Going back in time, related lines must approach. And while monocots are admittedly more recent than dicots, both appear old and may have arisen at much the same time.

Many of the Medullosans are giant forms, always more or less deceptive. But the woody cylinder in the different types was of a very varied structure, greatly subject to reduction, or, as may equally be said, less giant development and specialization. The secondary wood is soon lost by the leaf traces as they leave the parent stele, and the steles themselves are subject to diminution. Consequently, with the monocot-like bundle features and distribution in the petioles most marked, and the *sheer certainty* that vessels even could develop from the large tracheids, other tracheids becoming reduced, monocot relationships are a possibility.

The Medullosans display a fundamental difference from the cycadeoids, cycads and Lyginopterid seed ferns, in the absence of leaf gaps. The Myeloxylon "petioles" are merely branches, and the breaking up of the steles is due to unknown causes. Such are the unusual features that favored a transition from Myeloxylon-like structures into actual endogenous stems. In fact, Medullosa is at least semi-endogenous. Thus *Medullosa pusilla* of the lower Coal Measures is one of the smallest of all Medullosans, stem and leaf bases being only two centimeters in diameter; while according to Scott the *hypoderma* of the leaf trace is simpler and does not appear to have had any secondary tissue of its own on leaving the stele. And finally, Kubart beautifully figures *Heterangium Sturii* as a typical but primitive type without a secondary xylem cylinder. Such a stem could merge into or be taken as the end result of the loss of the Medullosan secondary wood; for Medullosa is only a polystelic *Heterangium*. And don't forget the sheathed bundles.

The monocotyledons are extreme herbaceous types. It has even been suggested that palms are in their second childhood. There is no enclosing tubular stele. Secondary growth is replaced by peculiar development of strand sclerenchyma. The foliar supply is the great feature tied up with a dense peripheral bundle grouping. This is the antithesis of the dicotyl condition (stem) with progressive elimination of the large medulla and increasing importance of the secondary wood. Hence such a Medullosan stelar equivalent as Heterangium may have supreme importance as an evolutionary turning point, where the protostelic primary wood could easily lose its thin enclosing secondary xylem. The trigonid floral plan must also be old. Trigonocarpus, Seward considers "fairly assigned" to medullosans. (Fossil Plants III, 13.)

That the Medullosans, so to speak, reach the evolutionary parting of the ways has been in the mind of several paleobotanic writers. The Medulloseae or their immediate relatives may well stand near the point where one great race began to use secondary wood in its stem architecture, and another the sheathed bundle.

In the cycad *Encephalartos Barteri* there are in the seedling stem three concentric steles, each like a Medullosan stele, which unroll to form the xylem cylinder. And Miss DeFraine called attention to the fact that by loss of internal tracheids a Medullosan pro-

tostele like Sutcliffia could give rise to the cycadean woody cylinder. But the course of change could as easily occur in the reverse. The Medullosan protostelic strands could come to dominate, as the small amount of secondary wood in certain Heterangiums proves. For, as stated, each stele of such a type as *Medullosa Anglica* is the equivalent of the single cylinder of a Heterangium, both as to the primary and secondary wood; while the Heterangium primary wood extends to the stelar center in contrast to the medullated Lyginopteris. Yet in no case is a pith absent, and it is but a step to the Myeloxylon condition, foreshadowing, if not actually representing, early monocotyledonous structure. Again, Noé and his students have found the root structures which accord with these views of change toward the monocotyledons.

That the Medullosans include some of the precursors of later and higher types of flowering plants is a likelihood enhanced by the recent discoveries in the Devonian of the State of New York. The plants of the Gilboa forest are called *Eospermatopteris,* and are referred directly to the seed ferns. If the redintegration of *Eospermatopteris* by Dr. Goldring as based on the small cupulate seeds, microspore-disks, foliage and associated stumps is correct (and I believe it to be essentially so), an early Medullosan type comes into view. In the description of the stems it is said that some of the smaller ones show (well within the outer stereome zone) "toward the center an irregular ring of sclerenchyma tissue, and within this ring and to some extent outside it irregularly scattered strands of sclerenchyma tissue." All which befits a Medullosan, unless secondary to maceration and pressure. But the stumps show excellent preservation, taken as casts. Marked displacement or flotation of the wood or of any of the other tissues during fossilization seems little in evidence and this opinion is given from a huge symmetrical specimen brought from Gilboa by Professor Dunbar, of Yale. Apparently the Medullosan record extends all the way through the lower Carboniferous down into the Devonian, although what was already known of the group, particularly the relation to Heterangium, would have permitted the assumption of this early appearance, even as a giant form.

Going further, the symmetrically lobated microspore-bearing disk Codonotheca has not had the attention it deserves, not even from Kidston and Jongmans when their material demanded comparison. Codonotheca is probably a Neuropterid of Medullosan affinity, and it looks like some cupulate Rhabdocarpus seed attributed to Medullosa. The campanulas are extremely abundant. Split nodules from Mazon Creek no larger than one's hand sometimes bear three or four of the disks, some of which contain quantities of microspores; most singular if these merely drifted from other plants into position along the bundle ridges of the campanula. That is, the evidence, whether Rhabdocarpus and Codonotheca are ever amphisporangiate or not, suggests that some of the Medullosans bore flowers constructed on the cycadeoid and angiospermous plan.

The Medullosans lasted too long in geologic time, were too cosmopolitan, too varied of structure, to be unquestioningly classed as seed ferns or cycadophytes through all their record. If they advanced floristically as did the cycadeoids, and there is much reason to believe they did, the seed fern categories will shortly need revision. "Pteridosperms" have become overinclusive in fossil plant classifications, more especially those of Seward and Scott. But a few more years will bring determinative discoveries. In the prosecution of science nothing is so unfortunate, nothing so to be feared, as failure to admit the import of new or previously obscure facts which require expression and discussion.

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WHITE INDIANS OF DARIEN

THE story of the Marsh-Darien Expedition, organized and led by Richard O. Marsh, of Brockport, N. Y., has been told in detail in the daily press to the last of March, when it left the first base-camp, at Yavisa, in the lower Chucunaque Valley. During the preceding seven weeks southern Darien had been quite thoroughly explored without finding any blonde Indians, although Mr. Marsh had seen several at Yavisa in the summer of 1923. It is probable that any white Indians residing in that territory had hidden themselves because of the wild reports concerning the purposes of the expedition. But Mr. Marsh remained confident that white Indians would be found in the upper Chucunaque basin or in the Cordillera of northern Darien.

By the end of March, the Chokoi tribe in the lower Chucunaque Basin and the Cunas of the upper Tuyra Basin had been studied by John L. Baer, with skull measurements, and a considerable collection was made of Indian ornaments, utensils and structures. Many thousand feet of motion-picture film was taken by Charles Charlton, the Pathé photographer. Intensive study was made by Charles M. Breder of the lower vertebrates, and large collections secured. A large number of skins of birds and mammals were obtained by J. A. Johnson, the naturalist and taxidermist of the party. Some physiographic and meteorologic data also were obtained by the writer.

The failure to find any blonde Indians in southern Darien, while disappointing to Mr. Marsh, did not shake his confidence that they existed and that they would be found in the north. On March 27 the Ya-

visa camp was broken, and the writer returned to Panama with the collections to that date and part of the camp equipment, while the party of 12 white men and 15 Panamanians and negroes, in six piraguas with heavy equipment and supplies, "burned their bridges" and pushed north into entirely unknown and reputedly hostile territory. The northern district is occupied by Indian tribes that have inspired their neighbors with fear and have wisely and justly excluded intruders and have kept their blood pure.

The physical difficulties encountered by the party on the northward hike were much greater than any obstruction offered by the Indians. The time was the beginning of the wet season, while the rivers were yet low and the channels filled with log-jams and the scanty flow liable to sudden and heavy floods. In one stretch ten days were used in going 20 miles, it being necessary to chop and dynamite paths for the piraguas. During this terrible trip the party was reduced, by expiration of leave, by sickness, death and desertion. Senor Raul Brin, the Panamanian representative, was attacked by fever, returned to Panama and died. Mr. Baer had been weakened by blood-poisoning, due to "screw-worms," and died at Caledonia Bay after heart-breaking carriage across the mountains. The negro and Panamanian helpers dropped away, Mr. Breder fell ill and went to Colon, and the only original members of the party who remained with Marsh to the time when he found the white Indians were Charlton and Johnson.

The Indian people of the Atlantic coast of Darien, generally known as the San Blas, are a superior group in an advanced stage of culture, and must not be called "savages." They are threatened by the white man's diseases, by encroachment of the negroids and by what they claim to be unjust treatment by the authorities. When Mr. Marsh had crossed the Cordillera and reached Caledonia Bay with his reduced party he found the Indians in danger from smallpox. Going down to the coast to a navy wireless station on the coast of Colombia he obtained doctors and vaccine from Colon and checked the epidemic. This, along with extended conferences with the chiefs, won the confidence and friendship of the Indians. The chiefs, in assembly, agreed to follow his advice and accept his help in safeguarding their people. Then Mr. Marsh said that he wished to see their white people. They replied that there were no white Indians. Marsh told them that he knew there were, for he had proofs and had seen several. He also said that their white Indians would interest the people of the United States and form a bond of sympathy which would aid in securing their safety and protecting their rights. Then they called in the white Indians from their seclusion in the hills, and they appeared in great numbers. The moving and still pictures taken by Charlton will be evidence. About 400 blondes were seen and information given that they have villages in the hills of the Cordillera. Such a village had been seen by an army aviator.

Mr. Marsh was told that their legends were to the effect that white members had existed in the tribes from ancient times, but that their hatred of white Europeans, on account of the Spanish cruelty, had resulted in dislike of their own white people, and that they had tried to suppress them. The effect was their seclusion and segregation in less accessible districts.

Three white children were selected by Mr. Marsh from among many that were offered to him, and with five dark adults they were brought to New York on July 6. One of the blonde children is a robust girl of 14 years, the father and mother being among the five dark adults. These parents have had seven children, five being white and two dark. The mother's mother was a white Indian. The two other children are boys, one 14 and one 10 years, the latter selected as the best example seen of the dark blotching of the white skin. These children have golden hair, hazel or hazel-blue eyes and pink gums. Mr. Marsh says that he did not see a typical albino among the hundreds of blondes. He believes, from his observations on the San Blas, that there are at least three types of Indians, possibly due to the commingling on the isthmus of migrations from the northern and southern continents. He thinks that the white girl and her parents represent a type of larger frame, larger heads and generally a more lusty physique than the ordinary San Blas. He feels sure that the blonde strain will be found limited to this type.

We find here an interesting ethnologic problem. The evening of July 8 the Pathé News gave a dinner at the Waldorf-Astoria to Mr. Marsh and his Indians and members of his expedition, to which were invited a number of anthropologists. The white children were examined at this conference, and it was the unanimous opinion that the phenomenon was not albinism. Major Cuthbert Christy, of England, a specialist in tropical diseases, thought it was pathologic, due to some physiologic condition inhibiting pigmentation.

The anthropologists of the American Museum of Natural History examined the Indians and attributed the whiteness to albinism. Their report, given currency in the daily press and in the *Literary Digest* of August 9, contains, as stated by Mr. Marsh, an unfortunate error, that the smaller size of the heads of the dark Indians is due to massaging in infancy. This statement was based on reply by the Indians to questions which they misunderstood. When subsequently questioned by Mr. Marsh they repudiated with scorn and amusement the idea of any manipulation of the heads of the children.

In connection with the recent meeting at Toronto of the British Association three members of the Sec-

tion of Anthropology visited the Indians at their camp on the St. Lawrence, in the absence of Mr. Marsh, and concluded that the white characters were a form of albinism, and that ostracism had encouraged its propagation, as summarized by the chairman, Dr. F. C. Shrubsall, in a short presentation at the close of the meeting. Following this paper, Mr. Marsh made the following statement:

(1) The difference in size and shape between the skulls of the blonde Indians and those of the standard San Blas has been attributed to artificial deformation of those of the dark infants, while those of the white infants are natural. This is wholly untrue. The San Blas Indians do not massage nor in any way alter the heads of their children. The rounder, broader and higher crania of the whites can not be explained in that way.

(2) The timid demeanor of the children and the behavior of their eyes when under inspection by strangers is misleading. They are not mentally deficient nor abnormal in any way. On the contrary, they are unusually alert and keen, with excellent memory. They are rapidly learning English.

(3) That the blonde Indians do not spring from the normal San Blas Indians but from the larger and more robust type, which occupy the hills back from the coast.

It is evident that the great number of these blonde Indians and their birth from both white and dark parents present an interesting and important problem, either ethnologic or medical. Thus far we have the following tentative explanations:

(1) A peculiar form of transmissible and stabilized albinism. This names but does not explain. The blonde complexion, the procreation and the large number rule out ordinary albinism.

(2) Some disease or pathologic condition preventing pigmentation. It appears that the physiologic defect is transmissible as an acquired character.

(3) That the blondes are biologic "sports." This argues for a new variety or race of the human species.

(4) That the phenomenon is atavism, the effect of a long-ago infusion of white or Nordic blood. The anthropologists are inclined to discredit the many legends of ancient or Pre-Columbian immigration from Europe. But it may be wise to critically review the historic narratives.

One important matter is not yet determined, that is, if the white parents ever have dark children.

Summarizing, it would seem that we may be limited to two views. The first three of the above explanations suggest the initiation of a new white race, and fortifies the belief of many anthropologists that our own white race sprang from dark ancestry. Either this explanation or the ancient introduction of Nordic blood.

All agree that Mr. Marsh deserves great credit for his persistence in the face of great difficulties in making a very important discovery. Dr. Aleš Hrdlička has said:

> . . . The phenomenon deserves a thorough scientific investigation, and Mr. Marsh deserves the thanks of American and British anthropologists for having brought to their attention a subject of considerable scientific interest and importance.

It is the purpose of Mr. Marsh to make another expedition to Darien, equipped for thorough ethnologic and medical study. The Indians are very reticent about their family and tribal affairs, and it will require tactful and sympathetic handling to obtain the full truth concerning this matter.

Mr. Marsh is also intent on finding some way of establishing ownership by the Indians of the lands which they have held so long, of protecting them from the dangers that surround them, of assisting them in sanitation and agriculture and of helping them to live their own life in their own way. They are an admirable people and should not be encouraged to adopt the many vices which we call civilization.

The moving pictures taken by Mr. Charlton will soon give on the screen a vivid story of the Marsh Expedition.

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SCIENTIFIC EVENTS

THE WORLD POWER CONFERENCE[1]

THE World Power Conference held in London, June 30 to July 12 was, from many points of view, the most notable gathering of its kind ever convened. It attracted large representations of engineers from many nationalities to London, and the various sections of the program reviewed the power problems of the world with a completeness that has never before been attempted.

The conference was organized by the British Electrical and Allied Manufacturers' Association in cooperation with numerous technical, scientific and commercial organizations. The purpose was to consider the sources of world power by evaluating the resources of each country, by comparing experiences in the development of scientific agriculture, irrigation and transportation, by engineering conferences, by consultations of power consumers and power-machinery manufacturers, by financial and economic discussions, and by conferences looking to the establishment of a permanent world bureau for the collection of data and the exchange of industrial and scientific information.

The conference was formally opened on Monday

[1] From *Mechanical Engineering*.

afternoon, June 30, by the Prince of Wales in the large conference room of the British Empire Exhibition. Lord Derby, president of the conference, presided at this ceremony. In his address the Prince of Wales extended a cordial welcome to the delegates to the conference and expressed the hope that the personal contacts gained during the discussions would form the inspiring motive of progress in every great activity connected with modern industry. Sir Joseph Cook responded on behalf of the British Dominions, Dr. G. Semenza of Italy, spoke for the European countries, and O. C. Merrill, of the United States, replied for the Americas. Mr. Merrill received considerable applause when he stated that mutual understanding was badly needed in the world at the present time and that contacts between people more than contacts between governments would bring about that understanding.

More than four hundred papers were presented from over forty countries, which were classified for discussion under the following headings: Power Resources, Power Production, Power Transmission and Distribution, Power Utilization and General. Under this last heading financial, economic and legal considerations were discussed, as were also research, standardization, education, health and publicity. In the Survey of Engineering Progress in this issue will be found very brief abstracts of some of the foreign papers which deal with topics of outstanding importance. Forty papers presented by American authors summarized the results of American progress in power generation, transmission and utilization, and included a summary of American resources. The complete proceedings of the conference will be included in four volumes approximating 5,500 pages, which are to be published by Perry Lund, Humphries & Company, Ltd., 3, Amen Corner, London E. C. 4, England. The publishers will send a prospectus of contents upon application.

The technical sessions were held mornings and afternoons, sometimes three at a time, on the first ten week days of July. The meeting places were the conference halls at the British Empire Exhibition. The papers, which had been printed in advance, were presented by title and thrown open to discussion by the delegates present. Over one hundred and seventy-five Americans were at the conference and many of them participated actively in the technical sessions. Among the presiding officers were George Otis Smith, director of the U. S. Geological Survey; David S. Jacobus, John W. Lieb, John R. Freeman, Fred R. Low, Joseph W. Roe and R. A. Millikan. Arthur Surveyer, president of the Engineering Institute of Canada, presided at one of the sessions on Water Power Resources. Among those who discussed the various papers were W. L. R. Emmet, David Rushmore, W. S. Murray, Sanford Riley, O. F. Junggren, Geo. A. Orrok and Lieutenant R. B. Alexander.

At the concluding sessions, which were held on Friday, July 11, there was a review of the activities of the previous day's sessions and plans for future development were considered. At this session Mr. Merrill pointed out that the papers and discussions would be a source of reference to engineers and other for many years to come. Each country had brought its own contribution and the questions had been discussed in a spirit of confidence and cooperation. There had been general recognition of the fact that scientific knowledge was common property and should be used for the common purposes of mankind. Resolutions were passed asking that each country which participated in the conference create and maintain a permanent national power committee from which delegates would be appointed on an international executive committee which would for the time being carry out the necessary work arising from the conference. Another resolution recommended that the organization which had convened the London conference should remain as an organization during the transitional period. The following general resolution was unanimously carried: "That this conference is of the opinion that the world's most crying need to-day is greater production and manufacturing activity among its peoples under conditions which will promote individual prosperity and happiness, and that this can be largely achieved by the fuller development of national power resources and by the establishment of the most economical means for the general distribution and utilization of energy."

THE HEALTH COMMITTEE OF THE LEAGUE OF NATIONS

DR. O. R. EICHEL, director of the Division of Vital Statistics, on leave of absence and serving with the League of Nations, reports the following interview with Surgeon-General H. S. Cumming, chief of the United States Public Health Service, and U. S. Representative on the League Health Committee:

I am one of the ten members appointed by the International Health Office to the League Committee under the new arrangement just concluded between the two bodies. The close coordination of international public health work that has been made possible by the partial amalgamation of the two bodies is to be welcomed as a great step forward. I have been keenly interested in effecting this reform since 1919, for the previous situation bordered on the absurd. Practically the same representatives of practically the same governments (except the United States, which was a member of the office and not of the committee, and Japan, which was a member of the committee but not of the office) met and worked separately. Most of these anomalies have now been

abolished under the new arrangement, much to the benefit of public health.

The United States Government is very much interested in the opium question, especially so in view of the conference this fall for cutting down the production and manufacture of opium to the amounts needed for medical and scientific purposes. In this connection the figures of 450 milligrams of raw opium per head per year suggested by the League Health Committee is extremely valuable, for it gives us something to go on. However rough and tentative an estimate the figure represents, it is a first step to a solution of the problem. We are at present collecting data in the United States on our annual requirements for medical and scientific purposes, as a contribution to this enquiry.

The proposal of the health committee that a central bureau of epidemiological intelligence should be established in the Far East is an excellent thing, and the selection of Singapore as a site is an excellent choice that was made on the merits of the matter and not on political grounds. The Straits are a funnel through which practically all shipping bound east or west passes; the geographical position is central; wireless communications are good and the port is right on the harbor.

The proposal for a Far Eastern sanitary convention shows above all the crying need for bringing the Paris Sanitary Convention of 1912 up to date, when the proposed Far Eastern Convention could easily be incorporated as a special chapter in the new general convention.

The progress of malaria in Eastern Europe has become a grave international problem, particularly in the Balkans, Southern Russia and Turkey, and the enquiry in these areas that is about to be undertaken by a League Committee will be most valuable. The committee is composed of extremely able men, and the United States will be much interested in the work it accomplishes.

Lastly, I would say that the system of "interchanges" by which medical officers of health from many countries are enabled to study health problems in and establish personal contact with colleagues from other countries is extremely valuable. The development and consolidation of this branch of work is one of the most valuable things the league has done from the point of view of public health.

THE NATIONAL PHYSICAL LABORATORY

THE annual report of the National Physical Laboratory, London, signed by Sir Arthur Schuster, chairman of the executive committee, gives as summarized in the London *Times* full particulars of the work of the laboratory during 1923, under the following heads:

(1) General research; (2) maintenance of standards; (3) research carried out by the laboratory for the coordinating research boards and committees of the Department of Scientific and Industrial Research; (4) investigations and tests for which payment is made by other government departments; (5) investigations and tests carried out for payment by firms and other bodies.

The report states that the past year has been characterized by a steady growth of work in all departments of the laboratory. This has been mainly due to the demands made upon the laboratory from outside, and in particular to the requirements of other government departments. Owing to the general business depression there was a slight falling off in work for firms, as compared with the preceding year, but towards the end of the year this work also showed a tendency to recover. The growth of the work involved considerable pressure on the staff, and necessitated increase in the staff in nearly all departments.

The work comprised under the heading of maintenance of standards constitutes one of the most important functions of the laboratory. The Board of Trade is responsible for the custody of the primary British standards of length and mass and for arranging certain periodical intercomparisons of these standards. At the request of the Board of Trade, the laboratory has reeently undertaken the duty of making these intercomparisons on their behalf so long as the Superintendent of the Metrology Department continues to act as Deputy-Warden of the Standards. The close relationship thus established between the standards department of the board and the laboratory is expected to be of great value in maintaining uniformity in the fundamental measurements of length and mass. With reference to the resolutions adopted by the International Committee of Weights and Measures, the Department of Scientific and Industrial Research has also been requested by the Board of Trade to undertake an investigation into the use of a wavelength of light as a standard of length. This investigation was already included in the laboratory program for the current year, and, in response to the request of the board, steps have been taken to secure that the work shall be advanced as rapidly as possible.

Satisfactory progress has been made during the year with work on the fundamental electrical standards. The construction of the new cylinders for the ampere balance has been proceeding steadily, and it is hoped that these will be completed during the coming year. A series of comparisons has been made between one of the standard wire coils of the laboratory and the mercury ohm; for the realization of the latter the tubes used in 1912 by Mr. F. E. Smith have been again employed. The comparisons indicate that a slight increase in the dimensions of the tubes may have taken place, and the tubes are being recalibrated to check this supposition. Work on the new Schuster-Smith magnetometer is also well advanced.

The work undertaken for boards and committees of the Department of Scientific and Industrial Research has greatly increased, and a further considerable increase is anticipated during the year 1924–25. This,

the report says, is largely due to the activities of the research boards of the department in the coordination of work required by various government departments. It is manifest that this work must be expected to develop, and that the needs are most economically met by extending the facilities for research in existing institutions. The more important items of work recently undertaken by the laboratory for the coordinating research boards include a research on motor springs, and spring materials generally, which is of great importance to the War Office and other departments in respect of transport problems; an investigation into the properties of constructional materials at high temperatures; a research on big-end bearings desired by the Air Ministry, which is of general importance for high-speed engine design; experiments to determine a suitable yellow glass for railway signal lights, as well as colored glasses for ships and aircraft lights; and an investigation relating to pivots and jewels as employed in a variety of instruments of importance for naval, military and other purposes.

In the Radiology Division, a large number of tests have been made on X-ray protective materials, and a considerable amount of time has been devoted, as already mentioned, to the very important work of inspecting X-ray installations in hospitals. Good progress has nevertheless been made with a number of interesting researches, including an investigation into the scattering of gamma rays by matter, the excitation of X-ray bulbs by different high-tension generators, the relation between total and "local" ionization, the scattering of cathode particles when allowed to fall on different substances, and the structure of metallic crystals.

In the Optics Division, the main item of research for the year has been that connected with color standardization and spectrophotometry. Much attention has been directed to the problem of producing a satisfactory laboratory source of white light, for which a solution has not yet been found.

In the Photometry Division, the investigation into problems of illumination of buildings, originally undertaken for the Office of Works, has been extended to the study of daylight illumination, and much interesting work has been done. Experiments are in progress to determine the best arrangement of windows for one of the proposed galleries to be constructed in the new wing of the Tate Gallery.

EXPEDITION OF THE BISHOP MUSEUM

THE Bishop Museum will have at its disposal for the next two or three years the four-masted schooner *Kaimiloa* for research work in the South Seas. The boat will leave Honolulu on its first cruise about the middle of October. The first year's tentative schedule includes Malden, Starbuck, Tangareva, Rakahanga, Manihiki, Pukapuka and Manua Islands, and if conditions permit considerable time will be spent in the Tuamotus.

On the initial cruise, six members of the museum staff will constitute the scientific personnel: Stanley C. Ball, curator of collections; Kenneth P. Emory, ethnologist; Charles H. Edmondson, zoologist; Armstrong Sperry, assistant ethnologist and artist; Gerrit P. Wilder, associate in botany; and Mrs. Wilder, interpreter. The scientists will be guests of the owners of the *Kaimiloa,* Mr. and Mrs. Med R. Kellum, who will accompany the cruise on some of its expeditions. The personnel of the later trips has not yet been selected.

The museum plans to study the out-of-the-way islands of the Pacific, making botanical, zoological and geographical studies, but giving particular attention to an ethnological study of the natives. It is hoped that relations may be established between the museum and the residents of the islands which will pave the way for a broad scientific survey in the near future, and lead to betterment of conditions under which the natives live.

The schooner has a length of 200 feet and a 38-foot beam. It has been remodelled to meet the needs of the scientists, and will carry a fully equipped laboratory, wireless apparatus, refrigerating plant, a library and spacious comfortable living quarters.

SCIENTIFIC NOTES AND NEWS

THE centenary celebration of the founding of the Franklin Institute and the inauguration exercises of the Bartol Research Foundation open on September 17 with an address of welcome by the mayor of Philadelphia, and addresses by Dr. Wm. E. L. Eglin, president of the institute, and Professor Elihu Thomson, honorary chairman of the celebration committee. The program, printed in SCIENCE for August 8, contains the names of a large number of scientific men who are to give addresses, including the following from abroad: Sir Ernest Rutherford, Sir William Bragg, Professor W. L. Bragg, Professor E. G. Coker, Professor F. G. Donnan, Sir Charles Parsons, Professor J. S. E. Townsend, Professor Charles Fabry, Professor F. Haber and Professor P. Zeeman.

DEAN HUGH MILLER, dean of engineering in George Washington University, has been elected to be secretary of the engineering section of the American Association for the Advancement of Science, to complete the present term. Mr. L. W. Wallace, who has been secretary of the section for several years, found it necessary to resign on account of other duties. Correspondence regarding the engineering section should be addressed to Dean Miller.

DR. SHIRO TASHIRO, associate professor of biochemistry at the University of Cincinnati College of Medicine, who was awarded the Gakushün prize by the Imperial Academy of Arts and Sciences of Japan, has received from the Imperial University of Kioto the honorary degree of doctor of medical science.

THE British Institution of Mechanical Engineers has conferred an honorary membership upon President Fred R. Low, of the American Society of Mechanical Engineers.

THE University of Wales has conferred the honorary degree of M.Sc. on Dr. H. Drinkwater, of Wrexham, in recognition of his research in genetics and on the British flora, and that of LL.D. on Sir Donald MacAlister, Bt., on account of his distinguished services to medical science and as a university administrator.

DR. E. E. FREE, formerly of the United States Department of Agriculture, has assumed the editorship in chief of *The Scientific American*, filling the vacancy created by the resignation of Austin C. Lescarboura.

DR. CHARLES W. GOULD, of New York, has been elected president of the National Eugenics Research Association.

THE astronomer-royal, Sir Frank Dyson, has been appointed president of the Greenwich branch of the League of Nations Union, in succession to Sir Charles Stone.

GEORGE L. CLARK, formerly a National Research Fellow at Harvard University, has joined the staff of the research laboratory of applied chemistry at the Massachusetts Institute of Technology.

HAROLD ALMERT, consulting engineer, of Chicago, a charter member of the American Association of Engineers, was elected president of that organization at the recent annual meeting in San Francisco.

H. C. BERGER, formerly of the research staff, Bureau of Mines, has been appointed research chemist at the Gloucester plant of the Armstrong Cork & Insulation Co.

DR. DAVID FRASER HARRIS, professor of physiology at the Dalhousie University Faculty of Medicine, Halifax, Nova Scotia, has resigned.

J. H. MAIDEN, who for nearly twenty years has been government botanist of New South Wales and director of the Sydney Botanic Gardens, has retired under the age-limit.

ACCORDING to wireless messages the schooner *Bowdoin*, bearing the explorer Donald B. MacMillan and his party, arrived at Godthaab, Greenland, on August 28, with all on board well.

PROFESSOR HERBERT FREUNDLICH, of the Kaiser Wilhelm Institute, will be the foreign guest of honor at the third Colloid Symposium which is to be held at the University of Minnesota next June.

DR. VINCENT G. BABECKI, who will teach in the new school of public health being organized at Warsaw, and Dr. C. F. Chellappah, medical officer of health of the Government Sanitation Department of Ceylon, are studying public health administration in the United States as guests of the International Health Board.

BARON RODOLPHE DE SCHAUENSSE, Professor Joseph McGoldrick, Henry Norris and Alec Besso, returned on September 1 from Brazil, where they have been collecting birds and other animals under the auspices of the Philadelphia Zoological Society and the Academy of Natural Sciences of Philadelphia.

THE dedication and unveiling of a monument in memory of Dr. William Thomas Green Morton, who was the first to administer ether for a surgical operation publicly at the Massachusetts General Hospital, October 16, 1846, took place at Charlton, Massachusetts, his birthplace, on September 1.

A COMMITTEE has been formed in Chicago, with Dr. Frank Billings as chairman, charged with the collection of funds for the erection of a monument to Pasteur. The monument, to be executed by the French sculptor, M. Léon Hermant, will be constructed of stone or bronze at a cost of $30,000.

A MONUMENT in honor of the late Professor Grasset, the well known neurologist of Montpelier, was recently unveiled at Lamalou-les-Bains.

WILLIAM DANIEL HURD, for ten years director of extension service at the Massachusetts Agricultural College and western manager of the soil improvement committee of the National Fertilizer Association, has died in his forty-ninth year.

DR. ROBERT KIDSON, F.R.S., the distinguished British paleobotanist, died on July 13 at the age of seventy-two years.

DR. R. H. JUDE, for more than thirty years in charge of the mathematical and physical department of Rutherford College, England, has died, aged seventy-one years.

PROFESSOR P. NATORP, emeritus professor of philosophy in the University of Marburg, author of "The Logical Foundations of the Exact Sciences," and leader of the neo-Kantian school, has died, aged seventy years.

DR. ALOIS MRÁZEK, professor of zoology in the Charles (Bohemian) University of Prague, died on November 26, 1923, aged fifty-six years.

PROFESSOR ALBERT HESSE, German chemist and for

over twenty years editor of the *Chemische Zentralblatt*, died on May 10, aged fifty-seven years.

PROFESSOR LUZZATTO, reader in microscopy and biochemistry in the University of Ferrara, Italy, died on July 13 at the age of fifty years.

DR. M. PALAGYI, formerly professor of biology and natural philosophy in the University of Klausenburg and later professor at Budapest, has died, at the age of sixty-four years.

THE centennial of Charcot coincides with the twenty-fifth anniversary of the founding of the French Société de neurologie, and is to be celebrated by the Réunion annuelle de neurologie, announced for June, 1925. According to the *Journal* of the American Medical Association, two topics have been selected for discussion: "Migraine," to be introduced by V. Christiansen, of Copenhagen, and Pasteur Vallery-Radot, of Paris, and "Charcot's Disease" by V. Neri, Bologna; Van Bogaert, Antwerp, and I. Bertrand, Paris.

THE second Spanish Congress of Medical Science will be held at Seville next October.

ACCORDING to the *British Medical Journal* the Dutch Medical Association, which consists of sixty divisions with a membership of 3,373, or about 90 per cent. of all the practitioners in Holland, has celebrated its diamond jubilee by the issue of a memorial volume containing papers on Dutch medicine before the foundation of the association, Dr. A. F. H. de Lespinasse (its founder), the origin of the association, and the history of its library. The volume contains numerous portraits of officers of the association, including Drs. Daniels, Donders, Pel, Snellen, Stokvis, Treub and Wenckebach, as well as full-page illustrations from some of the rarer works in the association library.

THE thirteenth annual safety congress of the National Safety Council will be held at Louisville, Ky., September 29 to October 3. The *Journal* of the American Medical Association states that among others, the following addresses will be presented: "Industrial health as a purchasable commodity," Dr. Clare F. N. Schram, medical director, Fairbanks Morse and Company, "Health education of our foreign families," Dr. Amos W. Colcord, Carnegie Steel Company, "How to make a sanitary survey of an industrial plant," Dr. Charles L. Ferguson, Shelby Shoe Company, "Report of committee on benzol poisoning," Charles Edward A. Winslow, "Prevention of lead poisoning" (round table discussion), Dr. Wade Wright, assistant medical director, Metropolitan Life Insurance Company, and Frederick L. Hoffman, Babson Institute, Mass., "How a medical department may contribute to safety in the chemical indus[illegible]," Dr. Benjamin J. Slater, Eastman Kodak Company, Rochester, N. Y.

A PRIZE for the physiology and pathology of altitude has been founded by the Alpine Sanatorium of Semmering, Austria. According to *Nature*, one thousand gold krone are offered to the author of the best work accomplished or published in the last two years, which has extended our knowledge of the action of alpine climate on man. The prize is intended in the first instance for Austrians, but foreigners can also be considered if their work has been carried out in Austria.

UNIVERSITY AND EDUCATIONAL NOTES

BY the will of J. J. Arakelyan various colleges in this country and Turkey will benefit as follows: Constantinople College, Turkey, $10,000; Robert College, Turkey, $10,000; American University of Beirut, Turkey, $10,000; Berea College, $10,000; Piedmont College, $10,000; Gordon Bible College, $10,000; president and fellows of Harvard, $15,000; Antioch College, Ohio, $10,000; Atlanta Theological Seminary, Georgia, $5,000.

THREE thousand acres of land in Albania have been given to a new American college in that country by the Albanian Government, to be called the American-Albanian College of Agriculture and Trades. C. Telford Rickson has become president of the institution.

DR. KEOZO-DOHI, of the Tokyo Imperial University, has contributed $25,000 and his students and colleagues $7,500 for the establishment of a dermatologic museum at the university to celebrate his twenty-fifth anniversary as professor of dermatology.

THE Bethlem Royal Hospital has been admitted as a school of the University of London in the faculty of medicine for the purpose of research in psychological medicine.

THE new pathology building of McGill University Faculty of Medicine, Montreal, will be officially opened on Founder's Day, October 6, in the presence of leading pathologists of Great Britain, Canada and the United States.

DR. HAWLEY O. TAYLOR, recently head of the electrical department of Franklin Union, Boston, Mass., and formerly consulting physicist, Bureau of Standards, Washington, D. C., has been appointed head of the physics department of John Brown University, Sulphur Springs, Arkansas, a new institution which opens its doors this autumn.

DR. EUGENE R. WHITMORE, professor of bacteriology and preventive medicine in George Washington Medical School, has been appointed professor of bac-

teriology and pathology in Georgetown University Medical School and pathologist to Georgetown University Hospital, Washington, D. C.

DR. GERALD L. WENDT has resigned his position with the Standard Oil Company to take the position of dean of the school of chemistry and physics at the Pennsylvania State College.

DR. L. W. DURRELL, formerly assistant plant pathologist at the Iowa Agricultural Experiment Station, has been appointed head of the department of botany of the Colorado State Agricultural College.

A. A. PACKARD, instructor in physics at Syracuse University, has been appointed assistant professor of physics and mathematics at St. Stephens College, Annandale-on-Hudson, N. Y.

DR. C. C. MACDUFFEE, assistant professor of mathematics at Princeton University, has accepted an assistant professorship of mathematics at the Ohio State University.

DR. DONALD A. LAIRD, National Research Fellow in Psychology, has been appointed associate professor of psychology at Colgate University.

DR. DAVID MURRAY LYON, assistant physician to the Royal Infirmary, Edinburgh, has been appointed Christison professor of therapeutics in the University of Edinburgh in succession to Dr. J. C. Meakins, who has become professor of medicine at McGill University.

PROFESSOR W. J. DE HAAS, of Groningen, has been appointed to succeed Professor H. Kamerlingh Onnes, of Leyden, who has resigned.

DISCUSSION AND CORRESPONDENCE

AMERICAN USES OF GLOBES BEFORE 1800

IN reviewing the beautiful and instructive work on "Celestial and Terrestrial Globes,"[1] by Stevenson, I ventured the assertion that undoubtedly American discussions of globes could be found in the period before 1800, to which Dr. Stevenson confines his discussion. Colonial references are fairly numerous and as it may stimulate some further explanation along this line in this interesting period of American history I list here a few of the references which have come to my attention.

In 1753 Theophilus Grew, a professor at the academy in Philadelphia which has become the University of Pennsylvania, published a treatise on globes. The title reads:

The Description and *Use* of the *Globes*, Celestial and Terrestrial; With Variety for *Examples* For the Learner's *Exercises*: Intended for the Use of such Persons as would attain to the Knowledge of those *Instruments; But* Chiefly designed for the *Instruction* of the young *Gentlemen* at the *Aca-demy* in Philadelphia. To which is added *Rules* for working all the Cases in Plain and Spherical Triangles without a Scheme. By *Theophilus Grew*, Mathematical Professor. Germantown, Printed by *Christopher Sower*, 1753 [pp. 60, (2)].

Copies of the work are found in the Pennsylvania Historical Society Library[2] and in the library of the University of Pennsylvania.

After 16 pages of description Grew takes up the common problems on the use of both globes (pp. 17–45). A treatise on plane and spherical trigonometry is probably the earliest published in the United States. This begins with right triangles (pp. 46–47); oblique angled plain triangles (pp. 48–50); right angled spherical triangles (pp. 50–55), and oblique angled spherical triangles (pp. 55–60).

This little printed work is evidence of the widespread interest in globes in the colonies. Washington had a terrestrial globe in his library, now in the Mount Vernon Museum. Unfortunately the globe is in need of repairs and the name of the make could not be deciphered by the Custodian of the Museum, who courteously gave me information concerning it. Benjamin Franklin ("Writings," ed. A. H. Smith: Vol. III, New York, 1905, pp. 89–91) in writing on June 20, 1752, to his London correspondent, William Strahan, ordered a pair of globes.

> Please send me another of Popple's Maps of North America . . .; a Pair of Mrs. Senex's improved Globes, . . . (or Neal's improv'd Globes, if thought better than Senex's) the best and largest that may be had for (not exceeding) Eight Guineas.

In the *Kentucky Gazette* of May 23, 1789, Jeremiah Moriarty advertises that he "will teach dancing. Teaches geography and use of the globes, having a pair on a new construction with Captain Cook's discoveries."

In New England one would expect a lively interest in the subject; works on surveying, navigation and travel were in great demand. An able mathematician, Nathan Prince, of Harvard, advertised in the Boston *Evening Post* of Monday, April 4, 1743, that he proposes "on suitable Encouragement, to open a School . . . for the instructing of young Gentlemen in . . . Mathematicks . . . Geometry . . . Algebra . . . in Trigonometry and Navigation; in Geography and Astronomy, With the Use of the Globes, and the several kinds of Projecting the Sphere. . . .

[1] SCIENCE, Vol. 56, pp. 199–201, August 18, 1922.

[2] The writer is indebted to the librarian, Dr. Montgomery, for loaning this copy to the William L. Clements Library for his use.

American geographies like that of Payne (New York, 1798) commonly included sections on the globes. Payne discusses (Vol. I, pp. xxxiii–xxxviii) "Problems performed by the globe; Jedidiah Morse (American Geography, 3d ed'n, Boston, 1796) gives a ten-page discussion, with problems, on both Terrestrial and Celestial globes, and the same space is devoted to this topic in the first American edition (Philadelphia, 1794) of Guthries's Geography. It is worthy of note that David Rittenhouse contributed to the astronomical portion of the American edition.

The first astronomical book printed in America was the "Phisica, Speculatio . . . Accessit compendium sphere Campani," by Alonzo de Vera Cruz (Mexico, 1557). An examination of this work and later Mexican works in astronomy and geography would be likely to reveal some use of globes in Spanish America.

These notes are intended to indicate some of the various sources of information concerning early American uses of the globes and also their intimate connection with early astronomy and mathematics in the New World.

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ON THE EXCRETORY APPARATUS IN PARAMECIUM

CERTAIN observations[1] on the morphology of the contractile vacuole and feeding canals in *Paramecium caudatum* warrant the following conclusions:

The pore, contractile vacuole and canals (eight to eleven in number) form a continuous, permanent ectoplasmic *structure*. There is here, therefore, neither evidence of nor necessity for a sol-gel reversibility of the cytoplasm, as set forth by Taylor ('23) to explain the mechanism of the contractile vacuole in *Euplotes*.

In a longitudinal section through the cortex, at right angles to a perpendicular line drawn through the pore to the bottom of the vacuole, the pore is seen on the surface as a clear, circular opening continuous with the vacuole below, showing no intervening membrane. Longitudinal and cross sections through the axis of pore and vacuole also show that the pore and vacuole are continuous. The vacuole can be distinguished in all stages of systole and diastole so far observed. During the stage of maximum contraction it is a minute central space with delicate radiating tubes, each of which leads to the bulbous end of a feeding canal. As the canals give up their contents to the vacuole, the vacuole gradually increases in size; meanwhile, the bore of the canals diminishes. The distention of the vacuole in stages of diastole is at the expense of the proximal ends of the feeding canals. Thus, the walls of the canals are directly continuous with the wall of the vacuole. The pore, vacuole and canals make a permanent continuous structure.

The canals are slender tubes varying in extent and size according to their disposition and the stage of contraction of the vacuole. At the end of systole, when the vacuole may be said to be collapsed, each canal is markedly bulbous in that portion immediately distal to the radiation from the vacuole. In such a stage the canals may be likened to long-handled Indian clubs radially disposed with their bulbous ends in close proximity. As diastole progresses, the canals present more nearly parallel sides throughout their length. Toward the end of diastole and the beginning of systole, the canals show distentions farther away from the vacuole.

There is no evidence that the contractile vacuole is formed by accessory vacuoles, as described and figured by Khainsky ('10), nor does any section show a pulsatorial papilla or evagination, such as he describes.

This study, therefore, indicates that the excretory apparatus of *Paramecium caudatum* is a permanent, continuous *structure*.

A detailed account with illustrations will be published later.

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[1] These observations were largely on serial sections of Paramecia fixed with Gilson, Bouin, Meves, Benda, Flemming and Altmann among others, including solutions of iodides (*e.g.*, Lugol's and 2 per cent. anhydrous iodic acid). The Altmann fixation gave by far the best results: absolutely no shrinkage; mitochondria, oil drops and cilia perfectly preserved. Of the various staining methods used, iron hematoxylin gave the best results. I am indebted to Dr. E. E. Just for turning over to me these slides, study of which served as a basis for these observations.

THE RESISTANCE OF THE TYPHOID BACILLUS TO FREEZING

IN spite of the published work of Pearse, Sedgwick and Winslow, Park and North, most text-books on bacteriology state that Eb. typhi will resist freezing for a considerable time; and quote Taylor's investigation of the historic Plymouth epidemic in support of their views.

In a series of experiments conducted in this laboratory during the past year, Mr. W. A. Kreidler, a graduate student, obtained results which clearly indicate that this hypothesis is incorrect. Using artificial culture media, water, sterile and normal feces as the media in which the organisms were frozen, he was unable to obtain any growth of typhoid bacilli or the "Paras" after freezing for three weeks.

While we must realize that we can not exactly simulate natural conditions in the laboratory, it would seem that organisms which had been leading a saprogenic life for years would be more resistant to the conditions of the experiment than would the same organisms in a highly virulent parasitic condition.

The Plymouth typhoid epidemic was caused by a fresh and vigorous strain, as is indicated by the severity of the early cases. It is not likely, therefore, that it was caused by organisms which had been in a frozen medium for any length of time. I would suggest the theory that the epidemic was caused by the organisms in the feces which were deposited within a few days of the time the reservoir was opened, about the time of, or after, the thaw.

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ANALYZED SOUND

IN the issue of SCIENCE for July 4, 1924, an interesting discussion of "Analyzed sound" by Alexander Forbes appeared. This description of the several instances coming to his attention brought to mind an experience of mine with a similar phenomenon occurring at Oxford, Massachusetts, many years ago. Having very carefully kept journal records almost daily since 1898 of my thoughts, experiences, etc., in contact with all natural phenomena, I made a search of my journal and found the following record which I will copy just as written:

Aug. 11, 1902. Oxford, Mass.

As an early train passed by this morning, I noted a most remarkable echo every time it whistled. The first echo was immediate, sharp and distinct, appearing to rebound from a neighbor's buildings nearby. Some seconds after all was quiet, another faint, far-away musical echo came stealing up the valley, apparently emanating from a wooded hillside far away. The echo ever increased in intensity until it seemed to pervade every corner of the landscape, filling it with a wonderful harmony of sound that beat upon the air in ever fainter waves, ever becoming farther away, until the sounds could no longer be heard. At no time were the sounds loud but seemed to fall upon the ear in infinite waves, as if thrown back from some invisible dome overhead. It did not seem to be a terrestrial echo, but seemed to fill the skies overhead with sweet, spiritual sounds, that seemed also to reecho far back in the skies, one could not tell where. I think some obscure atmospheric condition overhead was responsible for this remarkable echo, the most exquisite, the most sweetly celestial sound I have ever heard in the skies.

At the time I was greatly impressed with this remarkable sound phenomenon, but I have never since heard anything even approaching this strange breaking up and reflection of a sound into musical tones such as occurred in this instance.

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IN connection with the article in SCIENCE of July 4, 1924 (page 5), on "Analyzed Sound," attention should be called to Lord Rayleigh's discussion of the phenomena half a century ago (*Nature*, 1873, Vol. VIII; "Theory of Sound," Chap. XV) under the title "Harmonic echoes." His conclusions from a mathematical investigation of the reflection of sound-waves from small surfaces, as tree trunks, were that the intensity of the reflected wave varied inversely as the fourth power of the wave length. The overtones in the echo of the voice would therefore be very much stronger relatively to the fundamental than in the original sounds and the effect might easily be called a change to the octave.

Many years ago there was such an echo at the Adirondack resort, Loon Lake, Franklin County, N. Y.

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SCIENTIFIC BOOKS

Extinct Plants and Problems of Evolution. By D. H. SCOTT. Pp. xiv + 240. Macmillan & Co. London, 1924.

THIS little book, founded upon a course of lectures given at the University College of Wales in 1922, is a largely non-technical and very readable account of the main points in our knowledge of fossil plants, written for the non-specialist.

The first chapter is an all too brief, but very illuminating, sketch of the present status of the various theories that have been advanced to explain the facts of evolution. A consideration of extinct floras is preceded by a very brief sketch of recent floras, and the former are taken up in the sequence from youngest to oldest. The great transformation periods of floral history are considered to have been the middle Devonian, the Permian and the mid-Cretaceous, ushering in respectively the so-called Carboniferous flora, the Mesozoic flora and the flowering plants. The consideration of the early Devonian flora is almost entirely devoted to considerations growing out of the recently discovered petrified material in the Rhynie chert, and showing certain bryophytic and algal characteristics. It seems to the reviewer that a somewhat misleading impression is given of the extent of the Permian transformation, which was really a gradual process when viewed in the true geological perspective. The consideration of the Mesozoic floras is

largely taken up with the Cycadophytes, and the author is seemingly greatly impressed with the analogies between the bisporangiate fructifications of the latter and those of certain angiosperms. The treatment of the flowering plants is very brief and, although avowedly incomplete, does not indicate any great knowledge of, or even interest in, the literature of the subject.

As is eminently proper in a book designed for a general audience, the author very fairly states all controverted questions and rightly refrains from arriving at decisions, which are indeed impossible in the present state of our knowledge. Without prejudice to his position he may, I think, be fairly said to favor the following propositions: That land plants probably arose from various specialized algal ancestors somewhat after the manner set forth in Church's speculations; that the vascular plants were consequently polyphyletic in origin and that the Rhyniaceae may have been reduction products of some algal stock; that the true ferns and the seed ferns were of independent origin; that there was a community of origin between the seed ferns and the Cordiatales, and that the conifers and the ginkgos took their origin from some cordiatalean-like ancestors; that there was a community of origin between the flowering plants and the Mesozoic cycadeoids, finally that on the whole the evidence is favorable to the truly Darwinian conception of an orderly and gradual evolution of the various plant phylae.

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SPECIAL ARTICLES

A MECHANISM FOR THE COORDINATION AND REGULATION OF THE MOVEMENT OF CILIA OF EPITHELIA

THAT the movement of cilia in epithelia is coordinated is a fact of universal observation, but a structural mechanism in epithelia, by which this coordination of movement is conditioned and facilitated, has not hitherto been demonstrated.

Many biologists, especially physiologists, finding nothing in the structure of living epithelia suggestive of a coordinating mechanism and no reference in the literature of morphology concerning a durable, structural organization adequate to account for coordination of ciliary movement, have concluded that such a mechanism is not essential and does not exist. To account for the observed coordination of ciliary movement in epithelia, G. H. Parker,[1] in 1919, definitely formulated his theory of "neuroid transmission" according to which the coordinating impulses that pass from cilium to cilium are conducted, not by structurally differentiated paths, but by virtue of "that elemental property of protoplasmic transmission from which true nervous activity has been evolved." According to Parker ciliated epithelia present favorable conditions for the study of this elemental form of transmission.

The regulation and control of ciliary movement, such that it is correlated with the changing conditions of the environment and physiological states of the organism, is also a fact that is established by observation and experiment, although there are biologists who assert that such regulation does not exist; ciliated epithelia, according to their view, being purely automatic in their movements and not adjustable to the changing states of the organism as a whole. J. L. Kellogg[2] holds to such a view, at least so far as the ciliated tracts of the palps of lamellibranch mollusks are concerned.

During the past year we have made careful cytological studies of ciliated cells and epithelial of the gills of several species of fresh-water mussels of the genera, Lampsilis and Quadrula, and have been successful in finding well-differentiated systems of fibers which fully satisfy all the requirements of coordinating and regulating mechanisms.

The differentiated mechanism we have been able to demonstrate in the latero-frontal ciliated epithelium of the gill of a species of Lampsilis is shown in Fig. 1, and is schematically represented in Fig. 2.

The cilia (C), in this type of epithelium, are paired, and members of pairs are fused at their tips (X). The number of pairs of cilia is approximately the same as the number of nuclei in the syncytial epithelium. A specialized cuticle is present at the external surface of the epithelium in which the cilia and their basal corpuscles (b) are implanted. In the proximal zone of cytoplasm, between the cuticle and the row of nuclei, a system of intra-cellular fibers or ciliary rootlets is chiefly distributed, although fibers belonging to the system may penetrate the cytoplasm between nuclei, and perhaps even to the basement membrane and the sub-epithelial layer of bipolar cells. This system of intra-cellular fibers may be analyzed as follows: each cilium splits, just below its basal corpuscle, into two fibers (m and n) which diverge at angles varying from 20 to 30 degrees, one to the right and one to the left in the plane of the row of cilia. The right hand branches (m and m′), originating from the members of a pair of cilia,

[1] G. H. Parker, "The elementary nervous system," Lippincott Company, 1919.

[2] J. L. Kellogg, "Ciliary mechanisms of lamellibranchs, with descriptions of anatomy," *Journ. Morph.*, Vol. 26, 1915.

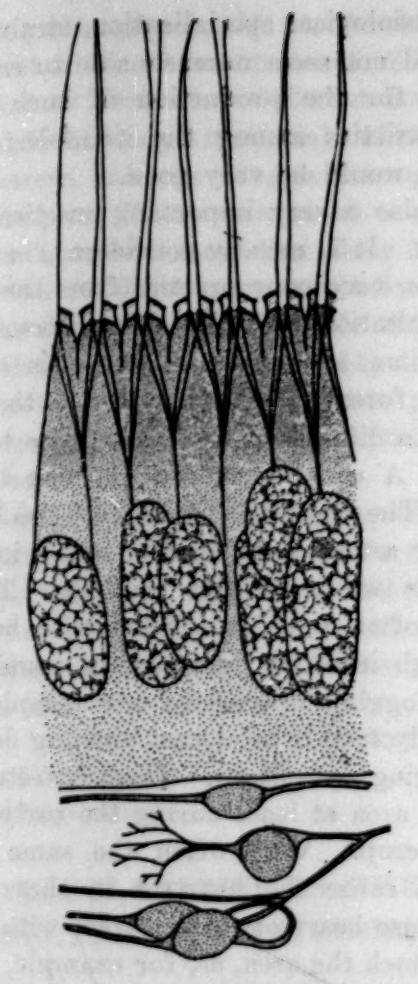

FIG. 1

gradually converge and join to form a single fiber (o), while the left hand branches (n and n′), join to form the fiber (o′). The fibers (o and o′) join with corresponding fibers derived from adjacent pairs of cilia, to form the fibers (p and p′) which may end on the nuclear membrane or penetrate the cytoplasm between nuclei. The part of this system, consisting of the fibers m, m′, n, n′, o and o′, forms a mechanism which is continuous throughout the extent of the epithelium and is postulated as that which provides a basis for the coordination of ciliary movement. The continuations of this system, through the fibers (p, p′, etc.) into the deeper parts of the epithelium, provide for the entry, into the system, of impulses, originating either in nuclei, the cytoplasm or bipolar cells of the subepithelium, by which movements of the cilia may be adaptively regulated in conformity with the state or needs of the organism as a whole.

In addition to the mechanism for the coordination of ciliary movement, just considered, another series of structures is present in each of the segments of the cuticle bounded by pairs of cilia, which apparently serves another purpose. One of these systems may be described as follows: a minute space (0) interrupts the continuity of the cuticle midway between pairs of cilia in the plane of the series of cilia. This space opens on the surface of the epithelium and, in section, appears to be formed between two fiber-like structures (r and l) which join the cuticular border above, in two-minute granules, and meet at the lower border of the cuticle, midway between the bases of the cilia of two pairs, in a similar granule. This latter granule is the meeting place also for two comparatively short, robust fibers (R and L) which originate, one from the nearest basal corpuscle of the pair of cilia on the right of the space, the other from the nearest basal corpuscle of the pair on the left, and it is the point of origin for a longer, unpaired, vertical fiber (S), which penetrates the cyto-

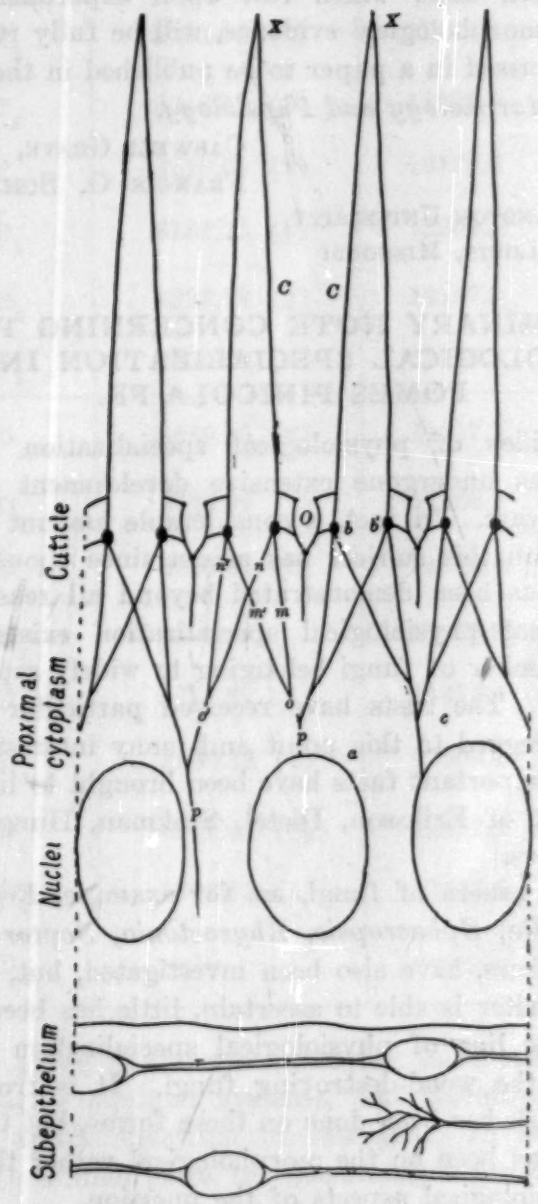

FIG. 2

plasm to a depth below the cuticle about twice the thickness of the cuticle. This series of cuticular structures requires further study. The fibers (R and L) may be interpreted to be a part of the mechanism for the coordination of ciliary movement. The spaces in the cuticle and their attendant fiber-like differentiations possibly represent a structural adaptation for taking up stresses and strains in the highly gelled cuticle incident to ciliary movement.

It may be too early to indulge in sweeping generalizations, but we venture to predict that similar structural differentiations will be found in all ciliated epithelia. The facts of comparative morphology justify such a prediction. Function is so universally found to be associated with, and to depend upon, definite structural organization of living substance that in a tissue so specialized in function as that of a ciliated epithelium we may expect *a priori* to find in it a corresponding structural differentiation that is neither indefinite in form nor of temporary duration.

The results of our investigation of various types of ciliated cells, which rest upon experimental as well as morphological evidence, will be fully reported and discussed in a paper to be published in the *Journal of Morphology and Physiology*.

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PRELIMINARY NOTE CONCERNING PHYSIOLOGICAL SPECIALIZATION IN FOMES PINICOLA FR.

The idea of physiological specialization in the fungi has undergone extensive development during recent years. In fact, a considerable amount of literature on this subject has arisen since about 1890, and it has been demonstrated beyond all reasonable doubt that physiological specialization exists in a great number of fungi belonging to widely separated families. The rusts have received particular attention in regard to this point and many interesting as well as important facts have been brought to light by the work of Eriksson, Dietel, Stakman, Hungerford and others.

Other genera of fungi, as, for example, *Erysiphe, Glomerella, Sphaeropsis, Rhyzoctonia, Septoria* and many others, have also been investigated, but, as far as the writer is able to ascertain, little has been done along the line of physiological specialization in the case of the wood-destroying fungi. It is true that some work has been done on these forms, but the emphasis has been on the morphological rather than on the physiological aspects of the question.

In regard to their general life history, many of the wood-destroying fungi differ from most other fungi in that they may, as a result of a single infection, inhabit a single host plant for a great number of years. For example, it is not impossible, nor even improbable, that *Echinodontium tinctorium, Fomes pinicola, Trametes pini,* etc., may grow in a tree as a result of a single infection for twenty-five, fifty or even a greater number of years. If, then, the character and general properties of the host plant exert any influence on the fungi infecting it, tending to produce physiological specialization, strains or varieties, it would not seem unreasonable to suppose that the chances for the production of such specialized forms or varieties among the wood-destroying Basidiomycetes would be very good.

There is also a very important practical aspect to this question. It is usually considered, in addition to other reasons, very poor practice from the standpoint of forest sanitation to allow infected trees to remain standing on an area upon which it is expected to raise future forest crops, even though these infected trees are of a different genus than those to be grown eventually. A concrete case will serve to elucidate this point. The white pine stands of the Inland Empire contain a considerable number of inferior species, such as white fir and hemlock. These latter species are often heavily infected with heartrot and many of such infected trees remain standing on the area after logging operations are completed. This is particularly true if broadcast burning does not follow the logging operations. These infected trees remain on the area at least during the early growth of the second crop. Very often the same species of fungi which cause the heartrot in these remaining trees also cause heartrots in the trees with which it is hoped to restock the area, as, for example, white pine. Thus *Trametes pini* causes more or less similar heartrots in fir, spruce, larch and pine. *Fomes pinicola* causes a red brown sapwood rot in spruce, larch, fir, pine and hemlock. *Echinodontium tinctorium* causes a heartrot in practically all the western true firs, Engelmann spruce, Douglas fir and western hemlock. Many other examples might be given, but the above are sufficient to illustrate the point. It is generally assumed, therefore, that these infected trees remaining on the area after logging constitute a menace to the future forest crop, even though it may be of a different genus. If, on the other hand, physiological specialization has developed to the extent that the strain common to white fir is limited to white fir, the Douglas fir strain to Douglas fir, etc., it is evident that the expense of falling and destroying these infected remaining trees might be eliminated when the forest sanitation is the only factor necessary to consider. The writer volunteers no expression of opinion on this point at this time, but merely calls attention to the situation.

It must be obvious that artificial infection experiments with the heartrot fungi are especially difficult and that it would take many years before any reliable data could be obtained. However, studies can be made on the physiological characteristics of these forms which may at least indicate the desirability of undertaking such artificial infection experiments, no matter how difficult or time-consuming the work may be.

The present note reports the results obtained from physiological study of four cultures of *Fomes pinicola* Fr. obtained from four different hosts, namely, Douglas fir (*Pseudotsuga taxifolia*), white fir (*Abies grandis*), western hemlock (*Tsuga heterophylla*) and western white pine (*Pinus monticola*).

The results obtained show that these four strains of *Fomes pinicola* differ very markedly in (1) the characteristics of growth, (2) the rate of growth, (3) the extra-cellular enzyme activity, (4) the intra-cellular enzyme activity, (5) the effects produced in mixed cultures, (6) the growth on liquid media and (7) the nitrogen relations.

The wood-destroying properties are now under observation, but since these experiments require long incubation periods, the results will not be available for some time. A detailed discussion of the question of physiological specialization in *Fomes pinicola* will be published later.

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SERIES REGULARITIES IN THE SPARK SPECTRUM OF NITROGEN[1]

During the past decade the spectroscopy laboratory of the Bureau of Standards has been investigating the arc spectra of the elements as far into the infra-red as modern photographic methods will permit. This work has revealed the fact that certain lines appear on practically all the spectrograms regardless of what elements have been employed as electrodes in the arc. These lines were correctly attributed to the gases of the atmosphere in which the arc operated; and subsequent investigations of the spectra emitted by tubes containing oxygen, nitrogen, and argon have established the chemical origin of all the atmospheric lines which have been observed in the red and near infra-red regions. Preliminary wave lengths have already been published for these lines. (*Publ. Amer. Astron. Soc.*, 4, pp. 170 and 363; also, Merrill, *Astroph. Jl.*, 51, p. 236).

It is the purpose of this note to direct attention to the fact that the nitrogen lines which are observed most frequently and belong apparently to the category of sensitive lines, result from combinations of a triple *p* term with an *s* term, another triple *p* term, and with a five-fold *d* term. According to the alternation law of Kossel and Sommerfeld the spectrum of non-ionized nitrogen should exhibit series regularities of even structure, while the spectrum of ionized nitrogen, conforming to the displacement law, should exhibit structures of odd multiplicity. The series regularities given in the accompanying table are of odd multiplicity (quintet system), and therefore belong to the spark spectrum of nitrogen. In the table, the first column gives the combining terms of which the inner quantum numbers are designated by subscripts, the second column gives the wave lengths and intensities of the lines, the third gives the vacuum wave numbers, and the fourth gives the wave-number separations of the common triple *p* term. The separations of all the polyfold terms involved follow approximately Landé's interval rule. Details of a more complete analysis of the spectrum will appear in a subsequent paper.

Term combination	λ I. A.	ν	Δν
S_2P_3	7468.74 (5)	13385.5	
			47.1
S_2P_2	7442.56 (4)	13432.6	
			33.7
S_2P_1	7423.88 (3)	13466.3	
P_3P_3	8216.46 (5)	12167.4	
			46.7
P_3P_2	8185.05 (3)	12214.1	
P_2P_3	8242.47 (3)	12129.0	
			46.5
P_2P_2	8210.94 (2)	12175.5	
			33.9
P_2P_1	8188.16 (3)	12209.4	
P_1P_2	8223.28 (3)	12157.3	
			33.6
P_1P_1	8200.59 (1)	12190.9	
P_3D_4	8680.35 (2)	11517.1	
P_3D_3	8718.99 (1)	11466.1	
			46.7
P_2D_3	8683.61 (2)	11512.8	
P_3D_2	——	(11428.7)	
			46.7
P_2D_2	8711.87 (1)	11475.4	
			33.7
P_1D_2	8686.38 (1)	11509.1	
P_2D_1	8729.07 (½)	11452.8	
			33.8
P_1D_1	8703.42 (1)	11486.6	
P_1D_0	——	——	

C. C. KIESS

BUREAU OF STANDARDS
AUGUST 14, 1924

[1] Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce.